Space Weather Forecast

Issued on Monday, 18 December 2023 at 00:42 Local

This forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Risk of G1 Minor Geomagnetic Storm until midweek UTC. Risk of further R1 Minor Radio Blackouts and S1 Minor Solar Radiation Storms soon much-reduced.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity rose to Moderate once again, with occasional Common-class flares that grew in magnitude and cadence to peak at 17/2017UTC from the departing large and complex sunspot region that has dominated the past week. This is the same group that had delivered the largest flare of solar cycle 25 so far in the form of a Strong flare on Thursday 14 December, however given its position on the extreme western edge of the facing side, the sunspot group was no longer discernible to determine its classification and ongoing risk.

Figure 1: SIDC ROB-processed register of Common-class flares and above from the last six days, as recorded by the satellite PROBA2. This can be seen to be dominated by the now offgoing large and complex sunspot region streaking across the northwest of the Sun (clustered stripe of white pixels on the right).

This left up to eight sunspot regions on the facing side, although these were mostly small, stable and magnetically unipolar, all impediments to activity. The main exception to this was a bipolar sunspot near the middle of the Sun, with this group seeing the emergence of an intermediate spot that then migrated westwards to join the leader in the period, although this was not capped by

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significant flare activity.

A 'filament eruption' (arc of plasma leaving the Sun) was observed on the far northeast in ground-based near-infrared imagery at 17/1700UTC. Whilst this has yet to be analysed, Earth impacts are considered unlikely given its emission location. A further northeastern event in the form of a possibly emissive mid-ranking Common class flare at 17/2132UTC from a new sunspot region may yet reveal a CME, with imagery awaited. There were numerous other Coronal Mass Ejections (CMEs) visible on imagery, however these were not considered to carry Earth-directed components. No new Earth-directed CMEs were therefore in evidence.

Solar Wind / Geomagnetic Activity: Solar winds were perhaps initially reflective of a modest fast wind. This gave way to a CME during a brief data gap between 17/0600 and 0730UTC, thought likely to be the potentially combined front of the 14 December northwest filament eruption and the 14 December Strong-class X-ray flare-associated CME.

The solar wind speed was initially stable but saw a discontinuity during the data outage to reach elevated levels mid-morning (UTC) before waning into the UTC evening. The number of particles associated with the solar wind was initially in its typical range, but saw a step-wise increase to an elevated peak that eventually relented in the final three hours of the 24. The associated magnetic field started slightly elevated, but then displayed an erratic character and became mainly anti-aligned with Earth's field for a time prior to 17/1530UTC, with a switch thereafter helping to moderate geomagnetic activity.

The net result of the above solar wind measures was for provisionally quiet to G1 Minor Geomagnetic Storm conditions, peaking in the 12-15UTC interval, while the magnetic field was most strongly anti-aligned with Earth's.

Energetic Particles / Solar Radiation: Proton flux was on a declining trend near resting background levels, having been raised in response to the recent larger flares from AR3514. It was below the S1/Minor Radiation Storm threshold throughout the last 24 hours, with an early peak of 1.8pfu (S1 starts at 10pfu).

Four-Day Space Weather Forecast Summary

Solar Activity: There is now a vestigial and decreased chance of further Moderate activity and a slight chance of Strong, should the recent large sunspot throw emissive ejecta clear of the western horizon that it now occupies in the first 24 hours of the forecast period. While some further active regions are likely over the eastern solar horizon into the new UTC working week, these are unlikely to adequately compensate for the loss, and there is a step-wise moderating risk of significant flares as a result.

Solar Wind / Geomagnetic Activity: There is now one further weak possible CME in the forecast, with arrival mooted for the very end of 19 or early on 20 December. The other component of the forecast, a persistent 'coronal hole' fast wind, is more assured, and is due on 19 December.

Geomagnetic activity carries a tail of risk of further G1 Minor Geomagnetic Storms into day one, Monday 18 December, falling to quiet into early Tuesday. Later that UTC day, there is a possibility of a coronal hole fast wind arriving and perhaps very late on the 15 December CME, with the effects of these perhaps combining to give a peak chance of G1 before this again wanes through midweek to leave a quiet end to the four-day forecast.

Energetic Particles / Solar Radiation: Proton flux is now just very slightly above background, with a slight chance of exceeding S1 again should the departing main large sunspot flare appropriately. This probability should then wane as this sunspot group progressively rotates from a

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potent position and further onto the far side.

Geomagnetic Storms:

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	40	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Radio Blackouts - X Ray Flares:

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	40	25	25	25
Very Active	R3 to R5 X	No	5	1	1	1

Solar Radiation Storms - (High Energy Protons):

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	15	10	10	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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